SPECIAL TOPIC

Updated Development of IMS Standardization

Abstract:
As the integrated core network for fixed and mobile access, the IP Multimedia Subsystem (IMS) adopts the mechanism that separates bear control from session control, as well as separates service control from session control, which greatly enhances the network capabilities. It's publicly regarded that IMS is the orientation of network evolvement and development nowadays. The international series of IMS standardizations are accomplished by the Third Generation Partnership Project (3GPP) and Telecommunications and Internet Converged Services and Protocols for Advanced Networking (TISPAN) standard organizations. This article covers the general standards of IMS by 3GPP and TISPAN, the research on the key technologies and hot issues of IMS. This includes the improvement and enhancement of core control part of IMS network, the existing problems in the interconnection and coexistence between IMS and Circuit Switching (CS) domain that are related to IMS. In addition, it includes the related research upon IMS in the Next Generation Network (NGN) R2 phase.

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The IP Multimedia Subsystem (IMS) is proposed by the Third Generation Partnership Project (3GPP) organization in R5, which is a general term for the logic functional entities on the network core layer that is controlled by IMS. The concept of IMS can be divided into the narrow sense and the broad sense. In the narrow sense, it refers to the logical functional entities involved in the network core control layer in version 3GPP R5 or above. In the broad sense, it's a general term based on the IMS network architecture. This article focuses on the description related to the network core control part.

The international oganizations for IMS standardization mainly include the 3GPP and Telecommunications and Internet Converged Services and Protocols for Advanced Networking (TISPAN). The 3GPP researches IMS from the mobile aspect, while TISPAN raises requirements for IMS from the fixed aspect. The 3GPP improves it in a unified sense, and eventually implements the unified control upon fixed and mobile access by IMS.

1 IMS Standardization by 3GPP

The IMS was first introduced by the 3GPP in R5, and has been further improved in R6 and R7. The IMS R5 has been frozen since September 2002, which emphasizes on the research of IMS basic structure, related functional entities, interactive flows between function entities, and more. The IMS R6 was frozen in March 2005. That emphasizes on the interconnection between IMS and external network including the interconnection with Circuit Switching (CS) domain, the interconnection with IP network, the interconnection with Wireless Local Area Network (WLAN), and the supporting of various services. The IMS R6 specifies that the services are provided and controlled by the home location of IMS subscribers. Therefore, the IMS becomes a real operable network technology. The IMS R7 would be frozen at the end of 2006, which is more concerned with the requirements upon fixed access, and based on absorbing the research results of TISPAN, including: Fixed Broadband Access to IMS (FBI), Circuit Switching and IMS Integrated Services (CSI), IMS emergency services, and more[1–2].

2 IMS Standardization by TISPAN

The TISPAN has been in close cooperation with the 3GPP on the research of IMS, and submits proposals to the 3GPP about the suggestion of amending IMS from the aspect of fixed access. Working in the similar way as the 3GPP, TISPAN issues different versions for different phases. Up to now, it has released the corresponding specifications of version R1, and is in the researching process of version R2.

(1) Phase R1

Considering the architecture, TISPAN adopts the IMS structure defined by 3GPP R7 (refer to TS.23.228 v.7.2.0), with corresponding amendments for the

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particular requirements. That is, raises the Network Attachment Subsystem (NASS) and the Resource and Admission Control Subsystem (RACS), including the architecture of the two subsystems and the interfaces between functional entities in these subsystems; gives the mechanism to support and achieve the PSTN/ISDN Emulation Subsystem (PES) based on IMS architecture, and more. Considering the protocol, the interface already defined by 3GPP and TISPAN makes corresponding amendments for the particular requirements of fixed access, defines the protocol between NASS and external interfaces, and defines the protocol between RACS and external interfaces. Considering the service, TISPAN defines how to implement the supplementary services of the traditional telecommunication network in the IMS structure.

(2) Phase R2

Presently, the R2 phase is mainly in the phase of requirement analysis, highlighting the projects of research on RACS R2, IPTV, Fixed–mobile Convergence (FMC), home network, and the improvement of PES structure. However, currently these projects have not made very great progress. Due to the pressures from various aspects, TISPAN has announced on the TISPAN 10Ter conference that the research on architecture can be free from the restrictions by the progress of requirement analysis, and can be gradually improved[3–4].

3 Hot Issues Related to IMS

3.1 Coordination Between 3GPP and TISPAN

The TISPAN has directly applied the related 3GPP contents in many specifications; therefore, the modification of 3GPP in its documents directly affects TISPAN. Consequently, 3GPP and TISPAN need to work out a solution for coordinating the standards between them. However, to date there is no uniform ideas yet.

3.2 Improving and Enhancing the Core Controlling Part of IMS Network

(1) Initial Filter Criteria and Dynamic Service Activation

In IMS, the Service–Call Session Control Function (S–CSCF) needs to check each initial filter criteria by sequence, but under certain scenarios, there is no necessity or possibility for such checking. The current solution in TISPAN is to add the "noService" parameter in the Route header in INVITE message sent by the Application Server (AS), to force the S–CSCF not to check the subsequent initial filter criteria.

The Dynamic Service Activation Information (DSAI) instructs whether to actually activate the service, rather than simply subscribe it. After a service has been activated or de–activated, AS can change the combination of initial filter criteria, to mask or unmask their subsets. The optimum solution is to allow the interaction between AS and the User Profile Server Function (UPSF), where AS only instructs whether the service is activated or not. At the same time UPSF maps this instruction to the initial filter criteria and then applies the actual masking logic. This solution separates the service subscription information and service active information, but requires expanding the S_h interface, and introduces a new structure into the S_h interface data model.

(2) Group Registration and Default Registration

The TISPAN has proposed the concept of group registration in the IMS–based PES solution, and expects 3GPP to expand the functions of corresponding functional entities of IMS, to support the group registration. However, the support of group registration will trigger the following problems:

- The single public user identity included in the Access Gateway Control Function (AGCF) group can not appear in the other service subscription; therefore, the public users identities included in AGCF cannot be part of other implicit registration group.
- Although the default registration can reduce the number of registration messages between AGCF and Interrogate/Service–Call Session Control Function (I/S–CSCF), the C_x interface will have the problem when downloading the large blocks of data in one message.
- The maximum valid period of registration is 600 000 s (about seven days), indicating that the associated Uniform Resource Identifier (URI) group should be refreshed once a week to the terminal.

Presently, about how to implement the group registration proposed by TISPAN, people are considering the specific processing method.

(3) E.164 Routing Problem

The IMS routing principle has the following problems. Currently, IMS assumes that the Telephone Number Mapping (ENUM) server is shared by all telecom operators. Under certain scenario, if the Session Initiation Protocol Uniform Resource Identifier (SIP URI) cannot be resolved from E.164, then the corresponding signaling message will be transferred to the Breakout Gateway Control Function (BGCF), which in fact is the functional entity implementing the E.164 routing function. If BGCF confirms the call that is in the BGCF of another IMS domain, a dead loop is formed, therefore, it's recommended supporting the E.164 routing mode by S–CSCF. Considering this problem, TISPAN will send the liaison to 3GPP for a solution.

3.3 Interconnection Between IMS and Other IP–based Network

On the TISPAN 10th conference, the Fourth Working Group has proposed two terms: Service–oriented Interconnection (SoIx) and Connectivity–oriented Interconnection (CoIx), and has carried out the research on problems related to NGN interconnection. The SoIx covers both the interconnections over the signaling control layer and the bearer layer, while CoIx covers only the simple interconnection over the bearer layer. As the interconnection involves the specific deployment of IMS, the corresponding research has not started yet. Besides, there are still differences between the functional entities related to interconnection defined by 3GPP and TISPAN, therefore, the consistency between the standards by these two standard organizations is still under discussion.

3.4 IMS and CS

(1) Voice Call Continuity

The Voice Call Continuity (VCC) service deals with the problem of one service over two networks, mainly as a

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problem of handover. The two-way handover should be considered, including handover from IMS domain to CS domain, and handover from CS domain to IMS domain. The VCC is proposed with the original intention of solving the coverage of mobile telecommunication system and WLAN, and the handover between the two.

Considering the specific solution, it's preliminarily divided into two camps. One is the IMS control plan based on IMS session control, in which the application layer implements the handover control. The other is the domain control plan initiated by the simulated Mobile Switching Center (MSC) intermediate handover, in which the IMS network is simulated as MSC for an inter-office handover. Presently, it's determined to adopt the IMS control plan.

The hot issues related to the research on VCC mainly highlight the following aspects.

• Architecture: Refer to the relationship and interactive structure between functional entities accomplishing VCC service control. Currently, its specific content has almost been determined.

• Processing mode of supplementary services: the IMS integrated control is a future orientation. It is the best way to process the supplementary services uniformly in IMS, but this cannot be realized in 3GPP R7 yet. Presently, the solution plan for supplementary services has the developing tendency of implementing partial control in CS domain and IMS domain respectively. Another compromising solution is that during the calling process, after the supplementary services have been performed, it's not allowed to perform handover again.

• Cross-domain routing selection: When the subscriber has been registered in the CS domain and the IMS domain, the cross-domain routing selection determines how to connect the call to the called party. In this case, the routing selection involves the operator's policy and the subscriber's preference.

Referring to other aspects, currently VCC does not support the emergency call, and only considers the interconnection of voice services. Therefore, the non-voice communication during the session needs to be further discussed. For instance, when a caller is performing the message service with the called party, it's very difficult to trigger the logic functional entities related to VCC in order to add voice communication. That is, the VCC has not solved the problem of adding the media service into a session. The current solution to this problem is to consider VCC as one feature service of the subscriber. Therefore, when the subscriber is a VCC subscriber, the service triggering function is started up, and the functional entities for VCC control accomplishes the corresponding service control.

(2) CS and IMS Integrated Service

The CSI is a service proposed particularly for mobile telecommunication and in nature it means that different services are provided by two networks. The real-time services are provided by the CS domain, while the non-real-time services are provided by IMS domain and pose relatively complicated requests upon the capability of terminals.

The specifications of CSI are relatively mature: to date the standards of Phase1 have been completed, while the research of Phase2 is in a standstill status.

In Phase1, the CSI service is not a user's subscription service, but a capability of the terminal.

The terminal has the function of associating the CS session and the IMS session. According to the information of the caller and the called party, presents them to the subscriber in one context, including the capability interaction between major terminals. The detailed working flow is the following:

• Interaction of radio capability: during the process of call establishment, two terminals interact the capability messages via the CS domain, based on the User-to-user Signaling Service1 (UUS1).

• Exchange of terminal capability: mainly to examine the terminal capability via the Option message in SIP protocol.

• Add an IMS session on the CS calls of the two terminals to establish the CSI service.

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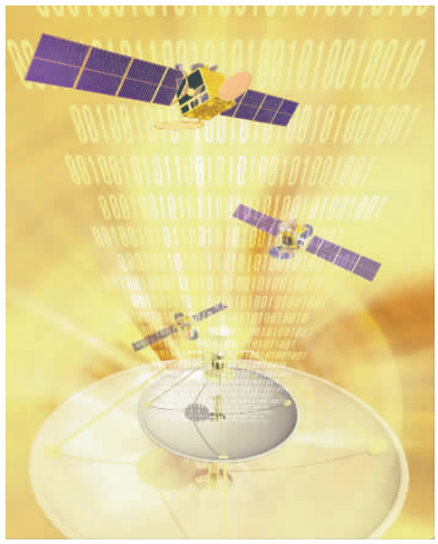

process of adding IMS session or CS call is independent of the ongoing call.

The key issues involved in CSI include:

• The method and timing of capability interaction.

• Triggering the IMS registration: If the IMS subscriber has not registered, the registration of this subscriber will be triggered. Although IMS subscriber might use the General Packet Radio Service (GPRS) as the IP-Connectivity Access Network (IP-CAN), GPRS might not be online permanently.

• Distinguishing the terminals of multi-terminal subscribers: In IMS, the subscriber might register the same public subscriber ID on different terminals at the same time; therefore, the IMS needs to make clear distinction and establishes the session onto the correct terminal.

• Processing the supplementary services: Currently the supplementary services in the two domains are processed separately, with no association between each other.

(3) Early IMS

Early IMS is proposed to solve the problem of connecting the 2.5G mobile terminal to IMS, with the key problem as how IMS authenticates the 2.5G mobile terminals. In the mode of username plus password, the password can be easily intercepted, and shared by several subscribers. However, it's the operator's wish that new services can be promoted via the simple configuration of the application server, to reduce the

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distinctions caused by different networks and different terminals as much as possible.

The current solution is the IP address bundling. When the Gateway GPRS Support Node (GGSN) assigns IP addresses to the terminal, it writes the IP addresses into the Home Location Register (HLR) and the Home Subscriber Server (HSS) at the same time. The HSS is in charge of associating the IP address with the International Mobile Subscriber Identity (IMSI). When the subscriber is registering, it compares whether the IP address is consistent to realize the authentication of the subscriber. In this processing mode, the protection of Proxy–Call Session Control Function (P–CSCF) might need to be reduced, that is, even without the security association, the call is allowed to pass. Besides, the P–CSCF must record the subscriber's real IP address, therefore, the subscriber is required to be in the same IP address domain with P–CSCF.

The Network Attachment Subsystem–Bundle (NASS–Bundle) is an authentication method raised by TISPAN for the subscribers of the fixed access. When NASS–Bundle and Early IMS coexist, there is the problem of how CSCF determines the authentication method, and it poses particular requirements upon both P–CSCF and S–CSCF. Presently, the solution for the coexistence of multiple authentications is still under discussion.

3.5 Research on IMS in NGN Phase R2

(1) IMS–based IPTV

The standard organizations such as Digital Video Broadcasting (DVB), American Alliance for Telecommunications Industry Solutions (ATIS), are researching the IPTV. As a part of NGN, the streaming media subsystem combines the fixed access and the mobile access. Presently, TISPAN has carried out the research on the implementation of IPTV under NGN, and is still in the phase of service capability and requirement analysis. For example, the analysis covers impacts upon the resource management, the subscriber data, billing and the subscriber's network attachment program. The IPTV services defined by TISPAN cover broadcasting TV, paid TV, interactive TV, and Video on Demand (VOD). It is mainly including the service definition, IPTV environment, description of various IPTV services, service distribution mode, related requirements of services, and network capability.

At the recent conference of TISPAN, it's suggested to carry out the research on the architecture of IPTV system, and to research the IMS–based plan and non–IMS–based plan at the same time. According to the consensus reached at the conference, when the service capability has not been finally determined, TISPAN initiates the research on the architecture of IPTV system, to promote the research on IPTV. Meanwhile, the analysis of IPTV capability requirements can be split into two projects. One is the requirement and network capability of supporting IPTV services, highlighting the capability requirement analysis of common components in NGN, including capability requirements of NASS and the RACS. The other is the requirement of integrating the ITPV and NGN service, such as the customized or interactive IPTV.

Currently, numerous functional entities have been defined in the research on TISPAN NGN, which might provide the functions to support IPTV services or enhance it to certain extent. Meanwhile, most core network control functional entities defined in IMS might accomplish the core control of IPTV services, to realize an IMS–based unified architecture for implementing the multimedia and IPTV at the same time.

Nowadays, IPTV is in commercial deployment in numerous places, and many related signalings have been defined, which have great impact for the research on IPTV.

(2) Fixed–mobile Convergence

The research on FMC has been carried out in TISPAN, currently concentrating on the analysis on various scenarios. The FMC covers a wide range of content and scenarios, and 3GPP FBI has made the research on many aspects, determining the research scope of TISPAN FMC, the priority of NGN R2 and more. To date, the specific scope of TISPAN FMC has not specified yet. It is neither clear whether to include the FMC of different layers, such as unified terminals, unified accounting bills, nor has it specified the distinct definition of FMC. Considering the development and research of FMC, it will influence IMS to a certain extent.

4 Conclusions

As the unified architecture incorporating the fixed and mobile access, IMS is the future orientation for the development and evolvement of telecommunication network. Its rich service capability spreads out a new chapter for the further development of telecommunication network. Presently, IMS for the mobile access is relatively mature, and the related manufacturer's equipment can provide relatively mature and complete functions as well. However, in the aspect of fixed access, especially if considering PES, there are still some unresolved problems, where the researching and standardization process lags behind. The IMS is mainly used to provide the multimedia services, while the researches on IPTV and FMC in the field of NGN will promote IMS into a new phase.

References

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